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NEW TAXA, NEW COMBINATIONS, KEYS AND COMMENTS ON GENERIC CONCEPTS OF *ZYGOPHYLLUM* AND A NEW SPECIES OF *TRIBULUS* (ZYGOPHYLLACEAE) IN THE MANUSCRIPTS OF THE LATE HJ. EICHLER

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Abstract

Manuscript notes made by Hj. Eichler indicated a new species of *Zygophyllum*, *Z. flavum*, in the *Z. ammophilum* complex and 3 new species, *Z. tetrapterum*, *Z. cuneatum* and *Z. verticillatum* in the *Z. aurantiacum* complex. All are formalised here, but *Z. cuneatum* and *Z. verticillatum* have been treated as subspecies i.e. *Z. aurantiacum* ssp. *cuneatum* and *Z. aurantiacum* ssp. *verticillatum*. Keys to both complexes had been drafted by Eichler.

Background

From the early 1960's, when he was based at the Herbarium of South Australia (AD), until his sudden death in 1992, Dr. Hansjoerg Eichler of the Australian National Herbarium (CANB) worked on Zygophyllaceae. He produced five papers (Eichler 1963, 1984, 1986, 1990, 1992) on the family and in his retirement was actively working on an account for the *Flora of Australia* with some funding from Australian Biological Resources Survey (ABRS).

The author was contracted to produce a *Flora of Australia* treatment of the family Zygophyllaceae during 1995. As part of this work Eichler's manuscripts and specimens were consulted. From these it became quite clear that he had recognised a number of new species for many years and these species were known not only through annotations on specimens in herbaria by Eichler but also by other botanists who identified *Zygophyllaceae*, for example W.R. Barker in AD and R. Cranfield and M. Lawrence in PERTH. Within the manuscripts left by Eichler there were no formal descriptions of any of these species, although there were notes on the morphology of individual specimens under a number of species made both by Eichler and by Alison Rowell who worked with him under ABRS funding in Canberra. Rowell had also plotted distributions of characters and collections in some of the complexes e.g. an analysis of the leaf lengths of *Z. aurantiacum* and *Z. verticillatum*.

Within *Tribulus*, Lawrence (1992) indicated that she had been told by Eichler that the name *T. platypterus* Benth. had been misapplied to specimens with prominent corky outgrowths on the stems. Within his manuscripts, Eichler consistently used the name *T. suberosus* for this species and had obviously communicated this name to Lawrence since all PERTH specimens received on loan were annotated with this name by her. Specimens in MEL were also annotated by Eichler with this name.

Within ZYGLIT, a computer data-base maintained by Eichler on the literature of Zygophyllaceae in Australia, begun in October 1990 and with the last printout dated April 1992, he indicated his intention to publish *T. suberosus*, *Z. cuneatum*, *Z. flavum*, *Z. kalgoorliense*, *Z. lobulatum*, *Z. tetrapterum* and *Z. verticillatum* in 199*. All of these names are published below, with the exception of *Z. kalgoorliense*. Unlike the other species, for this name there are few clues as to its identity apart from the name. It is listed in another data-base of names and types, ZYGUS, but again, unlike the other species cited, there is

no type mentioned. There are no specimens annotated with this name but it may relate to a very small-flowered, possibly annual, form of *Z. eremaeum* from the Kalgoorlie area.

The descriptions which appear below for all of the new taxa have been compiled by me from specimens predominantly annotated by Eichler. In the case of *Zygophyllum*, the format is similar to that used by Eichler when he described four new species for inclusion in the *Flora of New South Wales* (Eichler 1990). The types all conform with those selected and listed by Eichler in ZYGASUS, the database of names and types (Nomenclator) for Australian Zygophyllaceae maintained by Eichler. Although the species concepts are Eichler's, authorship of the new taxa, by Article 46.3 of the *International Code of Botanical Nomenclature* (Greuter et al., 1994), should be cited as "H. Eichler ex R.M. Barker" since he did not supply the descriptions or diagnoses. Authorship of the new combination *Z. lobulatum*, on the other hand, should be cited as "H. Eichler in R.M. Barker" since no description or diagnosis was required.

It seems a pity that the distinctive 'Hj.', always used on his collections and also initially used by Hansjoerg when describing new species and making new combinations (see for examples Eichler 1965) has been replaced by the more sterile and less informative 'H.' in the "Authors of Plant Names" (Kew *Draft Index* culminating in Brummitt & Powell 1992). However Hansjoerg himself conformed with this in his later publications and it is used here.

ZYGOPHYLLUM

Generic Concept

A draft key found within the Eichler manuscripts indicates that he was considering recognising three genera within *Zygophyllum* s.lat. of Australia.

On the basis of the floral parts in threes, the heteromerous flowers and the amplexicaul two lobed leaves, *Z. howittii* was recognised as a distinct genus and *Roepera* was resurrected to cover the 4-winged fruited species with non appendaged filaments i.e. the *Z. aurantiacum* complex. *Zygophyllum* was confined to those species with 4- or 5-angled fruits.

No justification for these genera has been found, apart from the key, and because of time limitations and the desire not to burden the taxonomic literature with more, possibly superfluous names, the forthcoming treatment being prepared for *Flora of Australia* will treat all species as *Zygophyllum*. A cladistic analysis of the group is a long term aim, but this will require an in-depth investigation of the fruit morphology of the group.

The *Z. aurantiacum* complex

Within this group Eichler recognised three new species and there are many specimens annotated with his manuscript names. Two of them are formalised here as subspecies of *Zygophyllum aurantiacum* even though within his manuscripts *Z. verticillatum* was treated at specific level. One of the new species, *Z. tetrapterum*, is not included in the key. It is distinct from all but *Z. eremaeum* by the petals being of similar length to the sepals; from *Z. eremaeum* it can be distinguished by the wide net venation on the fruit and by the dissociation of the fruit into 4 winged nutlets.

Unlike the other three taxa, the manuscript name "*Z. reticulatum*" which occurs in the key, does not appear on any of the specimens annotated by Eichler. It is likely from the description of the fruit that it is the taxon annotated by him on some occasions as "*Zygophyllum* sp. (aff. *Z. fruticosum* DC.)"; the characteristic separating this taxon is the wide net venation found on the fruit, hence the term "reticulatum". This character is shared by the fruits of *Z. fruticosum* and *Z. tetrapterum*. The name has not been formalised here because the taxonomy of this group has still to be finalised and it appears to encompass a number of taxa.

Key to *Z. aurantiacum* complex (winged fruited species)

It should be emphasised that this was only a draft key and as such, not all information was given in opposing leads. Measurements in square brackets were missing from the key and have been supplied by the author. *Z. tetrapterum* was not included but the characters used to distinguish it are discussed above. A further taxon, sometimes referred to as *Z. "simplicifolium"* was not included in the key or within the manuscripts but I have seen occasional specimens inscribed with this name. Note that in the original of this draft key *Roepera* was used as the generic name.

- 1 Flowers small; petals oblanceolate to narrow-elliptical, [3–4.2 (–5.5)] mm long, acute at apex, scarcely exceeding the sepals. Fruits indehiscent, 8–10 mm long, 1-seeded; wings very thin, papery, with numerous parallel veins..... *Z. eremaeum* (Diels)Ostenf.
- 1: Flowers larger; petals obovate, rounded at apex, distinctly exceeding the sepals. Capsule larger, sometimes dividing septicidally into 4 nutlets.
 - 2 Leaves sessile i.e. subterete leaflets in whorls of 4 inserted seemingly directly on the branches.....*Z. aurantiacum* ssp. *verticillatum* H. Eichler ex R.M. Barker
 - 2: Leaves distinctly petiolate.
 - 3 Leaflets oblong or linear, not distinctly articulate at base and almost as broad as the petiole. Flowers large. Petals [5.5–11] × [3–5.7] mm.
 - 4 Veins on wings of fruits many and almost parallel. Leaflets usually forming a narrow angle with each other i.e. V-shaped
 - 5 Leaflets narrow-oblong to linear, about as long as the linear petiole. Slender shrubs, usually straggling on other plants. Fruit [8.7–16] × [10–19] mm, usually splitting into 4 one- or two-seeded nutlets.....*Z. aurantiacum* ssp. *aurantiacum* (Lindl.)F. Muell.
 - 5: Leaflets broad, shorter than to almost as long as the cuneate petiole into which they are confluent. Stronger semiglobular, independent subshrubs. Fruit [15–20] × [14–15.5] mm.....*Z. aurantiacum* ssp. *cuneatum* H. Eichler ex R.M. Barker
 - 4: Veins on wings of fruit forming a wide-meshed net and not conspicuously densely parallel. Leaflets spreading almost at right angles to petiole (leaf T-shaped).....*Z. "reticulatum"* H. Eichler MS
 - 3: Leaflets lanceolate (slightly falcate) to narrow elliptical, distinctly articulate at base. Wings of fruits with wide net venation. Fruit [11–25] × [11–30] mm. [Petals 5.2–7 × 2.4–3.2 mm].....*Z. fruticosum* DC.

***Zygothylum aurantiacum* ssp. *cuneatum* H. Eichler ex R.M. Barker, ssp. nov.**

Subspecies nova *Z. aurantiaco* ssp. *aurantico* proxima sed differt foliis petiolo longo obovato cuneato et foliolis minoribus.

Holotypus: *R. Schodde* s.n., 23 Aug.1956, Stockyards, Head Station, Koonamore, South Australia (AD96430231).

Spreading, glabrous, woody perennial shrub, 20–50 (–100) cm high, wider than high. *Leaves* apparently simple, consisting of obovate or obtriangular petiole, bi- or more rarely, tri-lobed at apex; leaflets very short, ?succulent, broadly to transversely ovate, 1–6 mm long, 2–4 mm wide, continuous with petiole, rounded obtuse at the apex; petiole 13.5–18.5 mm long, 6.5–13 mm wide (at widest point), flattened.

Confined to South Australia where it has been recorded from the Lake Eyre, Gairdner-Torrens and Flinders Ranges regions. Flowers July to October, with one record for December, presumably in an unusual year. Recorded from limestone areas or from sand.

The apparently simple, cuneate leaves with a shallowly bilobed apex are very distinctive, but no other character difference is apparent from ssp. *aurantiacum* with its distinctly Y-shaped leaves.

Selected specimens annotated by Eichler as *Z. cuneatum*: *T.R.N. Lothian* 2041; *Bates* 19341; *N.N. Donner* 7413, Serpentine Lakes (AD); *N.N. Donner* 7408, Serpentine Lakes (AD); *N.N. Donner* 7413, 25 Aug. 1980, Serpentine Lakes, (AD); *F. Mollemans* 752, Gypseous Island in the NW corner of Lake Anthony, Commonwealth Hill Station, 140 km west of Coober Pedy (AD); *T.G.B. Osborn* s.n., 8.viii.1924, Koonamore House, Koonamore (AD, OXF); *D.E. Symon* 5605, 24 km NE of Mundy Ck on road to Mumpewic Stn. (AD); *D.E. Symon* 14567, Dalhousie, erosion gully in W facing slope of dolomite capped mesa (AD, BRI); *D.E. Symon* 16674, Moralanla Stn, limestone rise at Whim Paddock (AD); *L.D. Williams* 7739, 27.5 km NNE Frome Downs H.S. (AD)

***Zygophyllum aurantiacum* ssp. *verticillatum* H. Eichler ex R.M. Barker, ssp. nov.**

Subspecies nova *Z. aurantico* ssp. *aurantico* proxima sed differt foliis subsessilibus es sessilibus.

Holotypus: *Hj. Eichler 17952*, 17 July 1964, 5 km S of Leigh Creek, Northern Flinders Ranges, South Australia (AD); isotypi: to be distributed.

Low, spreading, glabrous, perennial shrub, 30–60 cm high and wide. Leaves sessile (bilobed from base); leaflets succulent, linear or narrowly elliptic, 5–20 (–28) mm long, (0.6–) 0.9–1.9 (–3.2) mm wide, not articulated at base, obtuse, acute or truncate at the apex; petiole lacking.

Confined to South Australia where it has been recorded from the Lake Eyre, Gairdner-Torrens, Flinders Ranges and Eastern regions. Flowers July to September.

The leaves, which are sessile and bilobed from the base, appear more like 4 linear leaves arising from each axil at first glance – hence the epithet '*verticillatum*'.

There is a note by Rowell (in the Eichler manuscripts) together with her analysis of the leaf lengths of *Z. aurantiacum* and *Z. "verticillatum"* that as the leaflet type is the only character used to separate the species it seems that *Z. verticillatum* may not qualify for specific rank. Eichler, in unpublished draft keys, treated the taxon at both the specific and subspecific level, but specimens have invariably been annotated by him as *Z. verticillatum*.

Selected specimens annotated by Eichler as *Z. verticillatum*: *N.N. Donner 133*, 8 km S of Brachina, Flinders Ranges (AD); *Hj. Eichler 12506*, c. 5 km NE of Koonamore HS along mail track to Cumamona (AD); *Hj. Eichler 17950*, Leigh Creek, at the northern end of the township along road to Marree (AD); *Hj. Eichler 17950*, Between Wilpena and Hawker, c. 6.5 km S of Arkaba (AD, CANB); *Hj. Eichler 13036*, Between Hawker and Parachilna, roadside near Hookina Rlwy Stn (AD); *R. Filson 3277*, c. 5 km E of Alberrie Ck, c. 55 km W of Marree (AD); *R. Hill 454*, Muloorina Stn, Frome River, c. 30 mls N of Marree (AD); *R. Schodde s.n.*, 23 Aug. 1956, Koonamore, 5 mls NE Head Station (AD, duplicates to be distributed); *J.Z. Weber 2716*, Banyeroo Valley northern part, c. 15 km W of headquarters, Oraparinna N.P. (AD)

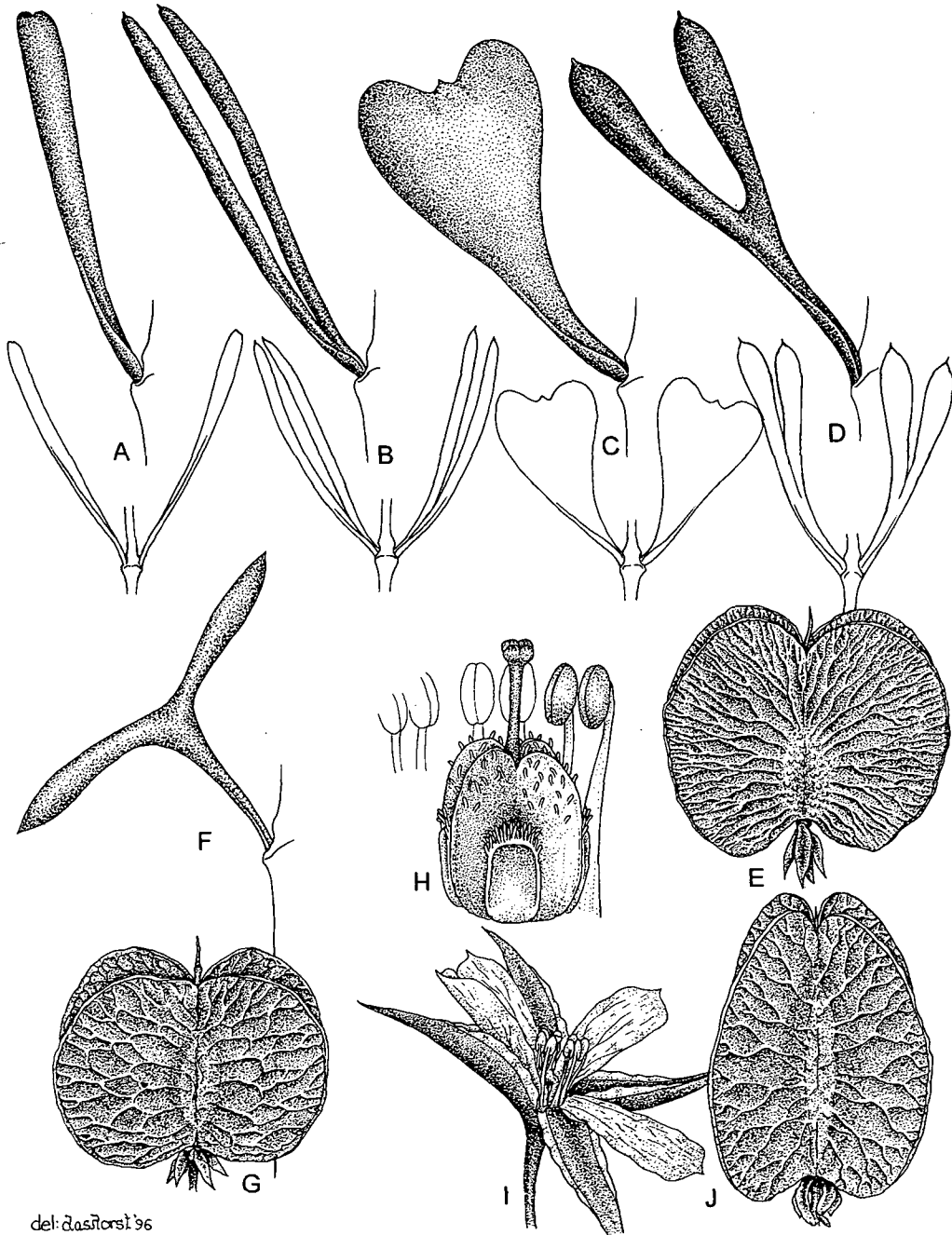
***Zygophyllum tetrapterum* H. Eichler ex R.M. Barker, sp. nov.**

Species nova *Z. aurantiaco*, *Z. fruticuloso* et *Z. eremaeo* proxima sed differt floribus cum petalis plus minusve sepalis, lobis oblongis nectarii, stylo brevioro, stigmate quattuor-lobo et fructibus venis reticulatis.

Holotypus: *Hj. Eichler 22993*, 11 Sep. 1982, W.A., Austin District. Ca. 27 km WSW of Menzies along the road to Diemals, at edge of salt swamp (CANB390422); isotypi: to be sent to AD, B, G, K, MEL, NSW, PERTH, US.

Decumbent, spreading, light green, glabrous, annual herb, 7–22 cm high, 20–30 cm wide. *Leaves* petiolate; leaflets succulent, oblong, 2–11 mm long, 0.8–1.8 mm wide, continuous with petiole, obtuse-rounded at the apex; petiole 2.5–13 mm long, flattened, similar width to leaflets. *Flowers* single at each node. *Pedicel* 3–4 mm long in flower, erect, 4.5–6 mm long in fruit. *Sepals* 4, lanceolate, 3 mm long. *Petals* 4, yellow, oblanceolate (lacking claw), 2.2–3.3 mm long, similar length to sepals. *Stamens* 8; filaments 1.5–1.7 mm long, gradually dilated to base, without appendages; anthers 0.5–0.7 mm long. *Disc* 4-lobed; lobes free, oblong, succulent, papillose on apex. *Ovary* 4-winged, 4-celled, glabrous, rarely papillose; style 0.1–0.6 mm long; stigma minute, 4-lobed. *Fruit* pendent, 4-winged, 10 mm long, cordate, elliptic with deeply emarginate apex, breaking into 4 winged, 1-celled fruitlets; fruitlets rounded at apex, with 1/2 seeds per cell; wing with wide net-venation; seeds 4.7 mm long, pale brown, elliptic, finely pitted.

Found in Western Australia in the area between Geraldton, Leonora and Southern Cross. Occurs in samphire flats at edge of salt lakes on gypsum, frequently with shrubs of *Atriplex*, *Frankenia*, *Selenothamnus* and *Lawrenzia*. Flowers August to October.



del: das 10/01/96

Fig. 1. Leaf and leaf pair of A, *Zygophyllum aurantiacum* (Lindl.) F. Muell. ssp. "simplicifolium" H. Eichler MS, $\times 2.5$ (R. Purdie 2845); B, - ssp. *verticillatum* H. Eichler ex R.M. Barker, $\times 3$ (R. Hill 1155); C, - ssp. *cuneatum* H. Eichler ex R.M. Barker, $\times 2.5$ (D.E. Symon 16674); D, - ssp. *aurantiacum*, $\times 2.5$ (S. Pillman 003912); E, fruit of ssp. *verticillatum* H. Eichler ex R.M. Barker (R. Hill 1155); F, G, leaf, $\times 2$, and fruit, $\times 2.5$, of *Z. "reticulatum"* H. Eichler MS (P.G. Wilson 7207); H, I, J, ovary with disc and anthers, $\times 2.5$, flower, $\times 7$, fruit, $\times 4$, of *Z. tetrapterum* H. Eichler ex R.M. Barker (H. Toelken 6088).

This species can be distinguished from the rest of the *Z. aurantiacum* complex by the flowers shorter than or equal to the sepals, by the 4 oblong disc lobes and by the tiny style and 4-lobed stigma. Markings on the fruit, which tends to be longer than broad, are widely reticulate.

Specimens examined and annotated by Eichler: W.A.: *T.E.H. Aplin* 2372, Lake Miranda (PERTH); *W.E. Blackall s.n.*, Sept. 1939, Yandil Stn (PERTH); *Cole* 4/60, Between Moora and Geraldton (PERTH); *R.J. Cranfield s.n.*, 20 Sept. 1978, Bullfinch (PERTH); *H. Demarz* 4586, 34 miles S of Burtville (PERTH); *Hj. Eichler* 23561, Lake Miranda, S end. 35 km N of Agnew (AD, CANB, PERTH); *C.A. Gardner & W.E. Blackall* 826, Lake Cowcowing, NW of Merredin (PERTH); *J.H. Maiden s.n.*, Sept. 1909, Southern Cross (NSW); *A.A. Mitchell* 1397, Lake Nanjuine, 50 km S of MKA (); *K. Newbey* 5870, Southern end of Lake Seabrook, c. 40 km NE of Southern Cross (PERTH); *R.D. Royce* 4499, Comet Vale (PERTH); *P.S. Short* 1544, Southern edge of Lake Miranda, near road running north from Agnew (AD, CANB, MEL, PERTH); *P.S. Short* 1988, c. 7 km N of Vermin Proof Fence in Hamersley Lakes region c. 76 km from Bullfinch along road to Mt Jackson (AD, CANB, MEL, PERTH); *P.S. Short* 2198, Edge of salt lake, western side of road, c. 10.7 km from Coorow, along road to Marchagee (CANB, MEL); *A. Strid* 20151, (B, M, K, PERTH); *H.R. Toelken* 6088, (AD, CANB); *P.G. Wilson* 6133, E side of Lake Moore, c. 85 km N of Koorda (PERTH); *P.G. Wilson* 7492, 30 km NE of Nambi HS which is 65 km NNE of Leonora (PERTH)

A key to the *Z. ammophilum* complex, including a new species, *Z. flavum*

The following is a key, found amongst the Eichler manuscripts, which includes all of the species of the *Z. ammophilum* complex. Four of these species, *Z. confluens*, *Z. angustifolium*, *Z. emarginatum* and *Z. simile* were published by Eichler in a precursor paper to the *Flora of New South Wales* (Eichler 1990). *Z. billardierei* is the only other species which can be confused with this group and it can be distinguished from all of the species except *Z. confluens* by its perennial habit and large flowers; it is distinct from *Z. confluens* by the leaflets being articulate with the petiole and is usually confined to coastal localities while *Z. confluens* is usually to be found in inland areas.

- 1 Perennial. Flowers large. Petals yellow, obovate, 10–12 mm long, distinctly longer than sepals. Leaflets linear, confluent with the petiole (not articulate). Capsule 8–10 mm long. Filaments subulate, abruptly widened at the base. Stamens 8. *Z. confluens* H. Eichler
- 1: Annual. Flowers smaller. Capsule usually shorter than 8 mm.
 - 2 Petals yellow, oblanceolate, as long as or slightly longer than the sepals. Style distinct; stigma simple. Stamens 8.
 - 3 Leaflets narrow. Capsule distinctly truncate (i.e. style base sunken), longer than broad.
 - 4 Leaflets almost terete, linear, distinctly articulate at base. Filaments subulate. Stems and branches very slender, usually supported by other plants. Capsule 6–8 mm long. *Z. angustifolium* H. Eichler
 - 4: Leaflets flat, linear-oblong. Filaments winged in lower third. Stems and branches short, self-supporting. Capsule 5–6 mm long. *Z. flavum* H. Eichler ex R.M. Barker
 - 3: Leaflets obovate-cuneate, broadest in upper third, distinctly emarginate. Capsule 4–6 mm long, rounded truncate (i.e. style base raised above edges), usually broader than long. Filaments winged in lower third. *Z. emarginatum* H. Eichler
 - 2: Petals white, shorter than to as long as sepals. Style very short; stigma 4-branched. Leaflets narrow-oblong. Capsule to 6 mm long.
 - 5 Stamens 8. Petals broad-ovate-cuneate, rounded to +/- 3-lobed at apex. *Z. simile* H. Eichler
 - 5: Stamens 4. Petals narrow-elliptical to narrow-obovate. *Z. ammophilum* F. Muell.

Zygophyllum flavum H. Eichler ex R.M. Barker, *sp. nov.*

Species nova *Z. ammophili* complexi, a *Z. confluenti* et *Z. billardierei* habitu annuo et floribus parvioribus, a *Z. simili* et *Z. ammophilo* petalis flavibus, sepalis longioribus et stylo distincto, a *Z. emarginato* foliis non emarginatis et a *Z. angustifolio* habitu non suffulto et filamentis alatis differt.

HOLOTYPE: *Hj. Eichler* 15320, 9 Nov. 1958, South Australia. Kangaroo Island, south-western part of the island. Near Hanson Bay; c. 4km S of South Coast Road, near the track on the western side of Sou'West River to Hanson Bay; on sand. (AD95914012) ISOTYPE: to be distributed.

Decumbent or straggly, glabrous annual shrub, to 40 cm high, wider than high. *Leaves* petiolate; leaflets usually longer and broader than flattened petiole, succulent, narrowly elliptic or narrowly obovate, often in unequal pairs, 5–15 (–20) mm long, 1.5–4 mm wide, constricted slightly at junction with petiole but not articulated, obtuse at the apex; petiole 5–10 mm long. *Pedice*l 2–4 mm long in flower, 2–5 mm long in fruit. *Sepals* 4, 3–5 mm long. *Petals* 4, light yellow, narrowly obovate, 3.5–5 mm long, usually just longer than sepals. *Stamens* 8; filaments c. 2 mm long, winged at base; anthers mm long. *Disc* 4-lobed; lobes free, semicircular, succulent, papillose on margin, less than half ovary height. *Ovary* 4-angled, 4-celled, glabrous; stigma capitate, not lobed. *Capsule* broadly obtriangular, 5.8–7 mm long, 5.7–7 mm wide, 4-angled, 4-celled, +/- truncate or obliquely truncate, with 1/2 seeds per cell; seeds reddish brown, verrucose, 3–4 mm long; fruiting style 1.3–1.6 mm long.

Flowering August to September for Eyre Peninsula populations but October to January for Kangaroo Island populations. There is some evidence to suggest that very small flowers are produced on the Kangaroo Island collections (personal observation). Ecology: sandy loam, particularly after fire (B. Overton, pers. comm.) or after disturbance.

Specimens examined

SOUTH AUSTRALIA: EYRE PENINSULA: *J.M. Black s.n.*, Tooligee, 110 km N of Port Lincoln, Eyre Peninsula (AD96246128); *J.M. Black s.n.*, 10 Nov. 1915, Tooligee (AD96246140 p.p.); *W. Gill (Conservator of Forests)* 29, Dec. 1911, near Warunda Station, Port Lincoln Railway (NSW144833); KANGAROO ISLAND: *P.G. Wilson* 633, S.W. Kangaroo Island (); *J.B. Cleland s.n.*, 15 km ENE of Cape de Couedic (AD96247266); *E.H. Ising s.n.*, 25 km SW of Kingscote (AD96246159); *Hj. Eichler* 18470, Vivonne Bay (AD); *S.A. White s.n.*, 26 Oct. 1908, Cape Borda, western end (AD97928037 p.p.)

In one preliminary key to *Zygophyllum* Eichler distinguished this species from *Z. emarginatum* by its narrow, almost linear, oblong cuneate leaflets and its distinctly truncate (style base at same level as edges) capsule which is longer than broad. In another key the two species were distinguished by the oblong rather than spatulate disc lobes and by the flattened rather than winged filament bases of *Z. flavum* compared to *Z. emarginatum*.

Z. flavum is distinct from *Z. confluens* and *Z. billardierei* by its annual habit and smaller flowers. It is further distinct from *Z. billardierei* by its non articulated leaflets, a character in which it also differs from *Z. angustifolium*, probably its most closely related species. *Z. angustifolium* usually sprawls within other vegetation whereas this species is apparently compact and self-supporting.

New combination in the *Z. iodocarpum* group of species and clarification of *Zygophyllum* sp. Karratha [J.S. Beard 3508].

Zygophyllum retivalve Domin

Zygophyllum retivalve Domin was described in 1926 from a specimen collected by Clement from between the Ashburton and De Grey Rivers. Within Eichler's manuscripts there are photographs of type collections from both PR and K.

Eichler was sent material of *Zygophyllum* specimens from Karratha which he identified as *Z. cf. retivalve* and this same material has been referred to in the PERTH herbarium as a priority taxon, *Zygophyllum* sp. Karratha [J.S. Beard 3508]. Most PERTH specimens on loan to Eichler in CANB have been annotated by him as *Z. retivalve* Domin and there seems little doubt that he considered the Karratha material to belong with *Z. retivalve* Domin.

Specimens annotated by Eichler as *Z. retivalve* Domin: *A.M. Ashby* 3206, 13 June 1970, 26° parallel, N.W.C.H. [North West Coastal Hwy] (PERTH); *A.C. Beaglehole* 11675, 19 Aug. 1965, 27 mls Sw of Tropic of Capricorn, NW coast Hwy (PERTH); *Y. Chadwick* 1478, 1 Sept. 1964, 6 km from Learmonth camp on Wapet

No. 4 well road, south 250 m from Cape Range (PERTH); *P. Glennon* 62, Aug. 1982, Pegs Ck, Karratha (PERTH); *D.W. Goodall* 1162, 12 July 1962, 2 km W of Learmonth (PERTH).

Zygophyllum lobulatum* (Benth.)H. Eichler in R.M. Barker, *comb. et stat. nov.

Zygophyllum iodocarpum var. *lobulatum* Benth., *Flora Australiensis* 1 (30 May 1863) 293; BASIONYM.

Type citation: W. Australia. Champion Bay, *Oldfield*.

Annotations on other specimens and within his manuscripts indicated that Eichler intended to raise *Zygophyllum iodocarpum* var. *lobulatum* Benth. to species level. This taxon is distinct by the presence of a lobe on the outer side at the base of each of the leaflets. It occurs along the Western Australian coast from Perth to Kalbarri and apparently occurs with *Z. retivalve* according to a note on the collection *Eichler* 23642. *Z. retivalve* is always glaucous in appearance while *Z. lobulatum* is not (noted from comparison of Eichler collections, *Eichler* 23622 and *Eichler* 23621, of the two taxa from one locality).

Specimens annotated by Eichler as *Z. lobulatum*: *D. & B. Bellairs* 2181, 20 Aug. 1978, 14 km S of Kalbarri (PERTH); *Hj. Eichler* 23622, 3 Sept. 1985, S of Coral Bay (AD, CANB, NSW, PERTH); *Hj. Eichler* 23642, 5 Sept. 1985, 26.9 km S of Wooramel (CANB, PERTH); *M. Koch* 1673, Sept. 1905, Watheroo Rabbit fence (MEL); *D. & N. McFarland*, Kalbarri Nat. Pk (CANB275197 & CANB275202, cited in MS); *G.L. Throssell & J.L. Hughes* s.n., 6 July 1953, Mendel via Mullewa (PERTH); *G.L. Throssell* s.n., Sept. 1953, Mendel (PERTH, 3 sheets); *Meaton* s.n., 1888, Upper Swan River (MEL95343).

Draft key to the Australian species of *Zygophyllum* by Hj. Eichler

Note that *Z. tetrapterum* and *Z. lobulatum* are not included in this key. As it appears here, *Z. tetrapterum* would key out to *Z. eremaeum* and *Z. lobulatum* would key out under *Z. hybridum*.

- 1 Capsule 3-celled, 1-seeded, each carpel with a broad vertical wing. Upper leaves amplexicaul *Z. howittii* F.Muell.
- 1: Capsule 4 or 5-celled. Upper leaves not amplexicaul.
 - 2 Flowers 4-merous. Capsule with 4 vertical angles or wings.
 - 3 Capsule with 4 vertical wings, not truncate; dehiscent in its entirety or in 4 segments corresponding to the carpels. Endocarp and exocarp not separating. Filaments subulate, not winged at base.
 - 4 Flowers small; petals oblanceolate to narrow-elliptic, acute at apex, scarcely exceeding the sepals. Capsule 8–10 mm long; wings very thin; seeds usually only 1–3 per capsule *Z. eremaeum* (Diels)Ostenf.
 - 4: Flowers larger, petals obovate, rounded at apex, distinctly exceeding the sepals. Capsule usually larger.
 - 5 Leaves sessile i.e. leaflets in whorls of 4 on the branch, subterete *Z. aurantiacum* subsp. *verticillatum* H. Eichler ex R.M. Barker
 - 5: Leaves with petioles.
 - 6 Leaflets lanceolate to narrow-elliptical, distinctly articulate at the base (not confluent in the petiole) *Z. fruticosum* DC.
 - 6: Leaflets oblong or linear, at their base about as broad as the petiole, not distinctly articulate.
 - 7 Leaflets narrow-oblong to linear, about as long as the linear petiole *Z. aurantiacum* (Lindl.)F.Muell. subsp. *aurantiacum*
 - 7: Leaflets broad (almost as long), shorter than the cuneate petiole into which they are gradually narrowed *Z. aurantiacum* subsp. *cuneatum* H. Eichler ex R.M. Barker
 - 3: Capsule not winged, opening loculicidally. Endocarp and exocarp separating.
 - 8 Capsule and ovary truncate at the summit.
 - 9 Stamens 8.
 - 10 Filaments subulate, not winged at base.
 - 11 Perennial. Flowers large; petals obovate, rounded or slightly emarginate, distinctly longer than the sepals. 63

- 12 Leaflets narrow-lanceolate to narrow-elliptical, distinctly articulate at base.
Capsule 10–12 mm long.....*Z. billardierei* DC.
- 12: Leaflets linear, not articulate at base. Capsule 8–10 mm long
.....*Z. confluens* H. Eichler [*stenophyllum* in MS]
- 11: Annual. Flowers smaller; Petals yellow, slightly longer than the sepals,
oblancoate, subacute. Leaflets narrow, almost terete. Capsule 6–8 mm long. Style
long with one small stigma at top.....*Z. angustifolium* H. Eichler
- 10: Filaments winged at the base. Petals pale to deep yellow, usually as long as or slightly
longer than the sepals.
- 13 Style very short; stigma usually 4-lobed.....*Z. simile* H. Eichler
- 13: Style distinct; stigma simple.
- 14 Leaflets narrow, almost linear-oblong-cuneate. Capsule distinctly truncate,
larger than broad.....*Z. flavum* H. Eichler ex R.M. Barker
- 14: Leaflets obovate or cuneate, distinctly emarginate and broader in the upper
third. Capsule with rounded truncate top i.e. style base higher than edges,
usually broader than long.....*Z. emarginatum* H. Eichler
- 9: Stamens 4. Style very short, ending in short stigmatic branches. Petals white, shorter or as
long as the sepals, obovate, usually rounded or truncate, sometimes slightly emarginate.
Leaflets narrow-oblong. Capsule c. 6 mm long.....*Z. ammophilum* F.Muell.
- 8: Ovary and capsule rounded at summit. Filaments winged at base.
- 15 Capsule sessile, narrow- +/- cylindrical, with 4 erect appendages at the summit
.....*Z. prismatothecum* F.Muell.
- 15: Capsule pedicellate, broad, without erect appendages at the summit.
- 16 Capsule 14–20 mm long. Leaflets large, 1–3 cm long and broad. Petals 8–15 mm long.
Plants usually stout.
- 17 Leaflets crenate towards the apex (usually with 3 blunt coarse teeth). Annual.
.....*Z. crenatum* F.Muell.
- 17: Leaflets entire. Perennial.
- 18 Wings of filaments entire, gradually tapering into the filaments. Seeds 1–2 in
each cell. Leaflets thick-fleshy, +/- continuous with petiole. Plant with erect
main stem. Sepals ovate, c. 3 mm long.....*Z. crassissimum* Ising
- 18: Wings of filaments truncate and denticulate at summit. Seeds 3–5 in each cell.
Leaflets thinner, +/- articulate. Plant diffusely branched from ground with
ascending branches. Sepals lanceolate, larger.....*Z. glaucum* F.Muell.
- 16 Capsule 3.5–10 mm long. Leaflets 4–15 mm long. Petals 1–6 mm long. Small annuals.
- 19 Capsule subglobular, 3.5 mm long, umbilicate at summit. Seed 1 in each cell.
Leaflets oblong-cuneate, faintly notched at apex. Petals yellow, slightly longer than
sepals.....*Z. humillimum* Koch
- 19: Capsule obovoid or ovoid, 7–10 mm long, rounded at summit and base, distinctly
longer than broad. Seeds 2–3 in each cell.
- 20 Petals yellow, twice as long as sepals. Capsule obovoid. Leaflets ovate or
orbicular, entire.....*Z. compressum* J. Black
- 20: Petals white, shorter than to as long as sepals. Capsule ovoid-oblong. Leaflets
narrowly cuneate, obtuse or faintly notched.....*Z. ovatum* Ewart & J.White
- 2: Flowers 5-merous. Ovary and capsule with 5 angles.
- 21 Ovary and capsule truncate at summit. Perennial. Leaflets obliquely ovate, entire, 1.5–4 cm long.
Seed 1 per cell.....*Z. apiculatum* F.Muell.
- 21: Ovary and capsule rounded at summit. Annuals. Leaflets oblong or cuneate, entire, notched, crenate
or obliquely lobed.
- 22 Leaflets towards the apex with coarse blunt teeth. Capsule oblong, c. 12 mm long. Seeds 3–4 in
each cell. Wings of filaments not toothed.....*Z. kochii* Tate
- 22: Leaflets entire or notched at apex.
- 23 Leaflets with one basal lobe at the outer margin. Capsule c. 10 mm long, upright. Wings of
filaments slightly toothed. Seeds 3–6 in each cell.....*Z. hybridum* Tate
- 23: Leaflets narrowed, not lobed at base. Capsule sub-globular, 5–9 mm long. Seeds 1 or 2 in
each cell.

- 24 Petals not or only slightly exceeding the sepals. Filaments broadly winged, but not toothed. Fruiting pedicels 3–4 mm long. Leaflets oblong-cuneate, notched at apex. Seeds shining, 1 in each cell *Z. iodocarpum* F.Muell.
- 24: Petals about twice as long as sepals. Filaments dilated but not winged in lower half. Fruiting pedicels c. 7–10 mm long. Leaflets entire.
- 25 Capsule c. 9 mm long. Seeds shining, (?2 in each cell). Leaflets obovate, 6–12 × 2.5–7 mm *Z. retivalve* Domin
- 25: Capsule c. 6–7 mm long. Seed not shining, 1 in each cell. Leaflets obliquely oblanceolate or oblong-elliptical, 6–10 mm long *Z. tesquorum* J.Black

TRIBULUS

Within the genus *Tribulus* there is a new species amongst specimens previously assigned to *T. platypterus* Benth. Lawrence (1992) referred to this species in her account of the genus for the Flora of the Kimberleys, stating that Eichler considered that the name *T. platypterus* had “been misapplied to more southerly specimens with prominent corky outgrowths covering all stem surfaces”. She therefore used *T. platypterus* for the specimens of the Kimberley and Eichler coined the manuscript name “*T. suberosus*” for the very corky specimens. Specimens in MEL have been annotated by Eichler with this name and many of the appropriate PERTH specimens have been annotated by Lawrence as “*T. suberosus* Eichler ms”.

While I can confirm that there are two taxa involved here, the correct usage of the name *T. platypterus* has to be confirmed by lectotypification. Within the protologue, Bentham refers to *T. platypterus* as being “glabrous except for the inside of the sepals” and the “older branches in one specimen corky”. He further refers to the sepals as being “glabrous outside like the rest of the plant, woolly-hairy inside”. From the description, it would appear that Bentham had available to him a mixture of the two species, since the woolly inside of the sepals is characteristic of one of the species while corkiness is characteristic of the other. However he only cited a Gregory collection from the “Hammersleys” [sic].

A MEL isosytype, MEL79454, a Gregory collection from east of the Hamersley Range, is very distinctly corky, but this specimen was not seen by Bentham. Fruits are present but it lacks any flowers. A specimen definitely seen and annotated by Bentham in Hooker’s herbarium at K, represented by a slide in the Eichler manuscripts, does not appear to be corky, but does appear to possess the very woolly-hairy inside of the sepals. This specimen is labelled “Hammersley” range as in the protologue, but is attributed to herb. Mueller rather than to Gregory. It matches well specimens collected by Maitland Brown of the same expedition, since it possesses both flowers and young fruits. The MEL duplicates, MEL79455 and MEL79456, both seen by Bentham are labelled as coming from “E of H [amersley] range, 2–3 feet high - tree. Rocky land” and “brought in from interior - Hammersley Range - Maitland Brown. Tree shrub - Nickol Bay”, respectively. Bentham has further annotated the first specimen as “*T. platypterus*/ very different from the African *T. alatus*”, and it would be appropriate for choice as lectotype.

It needs to be established whether there is Gregory material in K which might have been seen by Bentham, since he described the older branches in one specimen as being corky. Lectotypification is impossible until this is established but it seems clear that the name *T. platypterus* should be applied to specimens which agree with the Maitland Brown collections i.e. those which are not corky and which are woolly hairy inside the sepals, since the rest of the protologue description clearly relates to this species. This finding confirms Eichler’s decision to give a new name to the corky taxon.

***Tribulus platypterus* Benth., *Flora Austral.* 1 (30 May 1863) 289.**

Kallstroemia platyptera (Benth.) Engl. in Engler & Prantl, *Die Natürlichen Pflanzenfamilien* 3 (4) (Dec. 1890) 88.

Type citation: N. Australia. Hammersley [sic] range, *F. Gregory*. *Syntype:* Hammersley range, herb. *Mueller* [?] *Maitland Brown* s.n. (K); *syntype:* Brought in from interior - Hammersley Range, *Maitland Brown* s.n. (MEL79456); *syntype:* E of H[ammersley] range, Rocky land, *Maitl. Brown* s.n. (MEL79455); *isosyntype:* East of Hammersley Range, *F. Gregory* s.n. (MEL79454) belongs with *T. suberosus* - see below.

Found in the Hamersley area with, according to Lawrence (1992), a single record from the Kimberleys from north of Christmas Creek.

This species does not develop noticeable corkiness except in patches. It does occur together with *T. suberosus* in the Hamersleys (Olsson in litt. to Eichler, 10.iv.1986). *T. platypterus* differs from *T. suberosus* by its internally villous sepals, glabrous pedicels, longer styles and possibly shorter stigmas, easily dissociating fruit, these fruits only with sparse appressed white hairs. A further search for types is necessary before lectotypification is possible.

Tribulus suberosus* H. Eichler ex R.M. Barker, *sp. nov.

Species nova *T. platyptero* proxima sed differt caulibus suberosis, pediculis pubescentibus, fructibus tardius dissociantibus et pubescentibus et sepalis sparsius pubescentibus.

Tribulus platypterus auct. non Benth.; Benth., *Flora Austral.* 1 (30 May 1863) 289 p.p. (only as to Gregory collection).

Upright, spreading, subglabrous shrub, 30–100 cm high, up to 200 cm wide; stems with corky bark. *Leaves* in unequal pairs, with (1) 2–4 (5) pairs of leaflets above 2–5 mm long petiole; leaflets obliquely elliptic, sometimes narrowly so, shortly petiolate, very shortly acuminate, glabrous adaxially and abaxially, 3–8 mm long, 2.2–5 mm wide. Flowering pedicel 4–7 mm long, upright, fruiting pedicel 7.5–11 mm long. *Sepals* 6–7.5 mm long, glabrous or sparsely sericeous adaxially, sparsely sericeous or patchily villous abaxially. *Disc* glands 5, between sepals and petals. *Petals* 5 (–6), yellow, elliptic to narrowly elliptic, glabrous, 9–12 (–18) mm long, longer than sepals. *Stamens* 10, rarely 11 or 12, in 2 slightly unequal whorls, all fertile or some of them staminodal, at maturity equal to or longer than stigma; filaments 5.5–6 mm long; anthers 0.7–1.1 mm long but other stamens or ?staminodes with anthers linear and twice as long sometimes present. *Ovary* very densely white sericeous, 5-celled; ovules 2 per cell; style and stigma 2–4 mm long, style glabrous; stigma 5-ridged, papillose. *Fruit* a globose 5-winged schizocarp, 13–20 mm long, 18–25 mm wide, very tardily dissociating into 5 2-winged woody cocci, densely pubescent between wings, less so on wings, lacking any spines. **Cork hopbush.**

Found in the rocky hills and ranges from the Hamersleys to the edge of the Gibson Desert and south to Wiluna on a variety of soils. Flowering predominantly April to August, but also sporadically in other months.

Petals on the specimen collected from the Gunbarrel Hwy (*George 5480*) are much longer than usual, but further collections are needed from that area before it can be established whether this is of any taxonomic significance.

Selected PERTH specimens seen (annotated by M.E. Lawrence as *T. suberosus* Eichler MS): NW Coastal Hwy, 38.9 km S of Minilya, *M.E. Ballingall 2003* (PERTH); Cape Range, Charles Knife Road, *J.S. Beard 3574* (PERTH); 9 miles E of Wittenoom, *A.C. Beauglehole 11536* (PERTH); Rocky ranges of N.W. Cape, *T. Carter B1342* (PERTH); C. 23 km E of Wittenoom, *Hj. Eichler 22553* (CANB, MEL, NSW, PERTH); 21.5 miles E of Wangawol Stn. towards Carnegie Stn, *A. Fairall 1946* (PERTH); Vampire Gorge, Hamersley Range, *C.A. Gardner 12302* (PERTH); 25 miles WNW of Wiluna, *C.A. Gardner 2381* (PERTH); 25 miles WNW of Wiluna, *C.A. Gardner 2381* (PERTH); 19 miles W of Mt Nossiter, Gunbarrel Hwy, *A.S. George 5480* (PERTH); Cape Range, c. 1 mile S of lighthouse, *A.S. George 2558* (PERTH); Cape Range, S of Yardie Creek, *G.J. Keighery & N. Gibson 277* (PERTH); 20 km N of Roy Hill, c. 107 km N of Newman, *K. Newbey 10090* (PERTH); Kennedy Range, southern end by hill K39, c. 24 km NW of Gascoyne Junction, *P.G. Wilson 8440* (PERTH);

Acknowledgements

Hansjoerg Eichler was a personal friend to my husband Bill and me, as well as an esteemed botanical colleague and so there is a great deal of regret that he did not live to publish the species he had long recognised in *Zygophyllum*. I would have preferred that the authorship of the new species published here be his alone but the lack of any descriptions made this impossible.

Hansjoerg would have wished to acknowledge the contribution of Alison Rowell and Terena Lally, both of whom worked with him on Australian Biological Resources Study funding at CANB, the former on *Zygophyllum* and the latter on *Tribulus*. Terena also gathered together his manuscripts after his death for which I am grateful. I am also sure that Hansjoerg would have wished to acknowledge the long term help and support of his wife Marlies in a group of plants in which he had an interest since his first arrival in Adelaide.

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